



## A new species of shrimp of the genus *Periclimenaeus* Borradaile, 1915 (Decapoda: Caridea: Palaemonidae) from the southeastern Gulf of Mexico, including a key to the western Atlantic species of the genus

GABRIEL E. RAMOS-TAFUR<sup>1,2</sup> & RAFAEL LEMAITRE<sup>3</sup>

<sup>1</sup> University of Florida, Florida Museum of Natural History, Ichthyology Department, Dickinson Hall, Newell Dr. and Museum Rd., PO Box 117800, Gainesville, FL 32611, U. S. A.

<sup>2</sup> Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, 100 8<sup>th</sup> Ave. SE, St. Petersburg, FL 33701, U. S. A. E-mail: [Gabriel.Ramos@myFWC.com](mailto:Gabriel.Ramos@myFWC.com)

<sup>3</sup> Department of Invertebrate Zoology, Smithsonian Institution, National Museum of Natural History, 4210 Silver Hill Road, Suitland, MD 20746 U. S. A. E-mail: [lemaitrr@si.edu](mailto:lemaitrr@si.edu)

### Abstract

A new species of symbiotic palaemonid shrimp, *Periclimenaeus mcmichaeli* **sp. nov.**, is described based on a single male specimen collected near Dry Tortugas, Florida, in the southeastern Gulf of Mexico. This new species, the 14<sup>th</sup> now known for the genus *Periclimenaeus* Borradaile 1915 from the western Atlantic, is morphologically most similar to *P. wilsoni* (Hay, 1917), from which it can be separated by the presence in the new species of two small subdistal teeth on the ventral margin of the rostrum, absence of small spinules or tubercles on ventral margin of the meri of the major and minor chelipeds, presence of three teeth on the cutting edge of the dactylus of the minor chela, and position of dorsal spines on the telson. The presence in this new species of a prominent acute projection on each pleurae of the third and fourth somite is documented, and appears to be a character previously overlooked in the taxonomic literature of species of the genus. This new species is compared with other similar congeners from the western Atlantic as well as other oceanic regions. An updated diagnosis for *P. wilsoni*, and a key to identify the western Atlantic species of the genus, are also presented.

**Key words:** *Periclimenaeus mcmichaeli*, new species, Decapoda, Caridea, Palaemonidae, Dry Tortugas, Florida, Gulf of Mexico

### Resumen

Se describe una nueva especie de camarón palaemónido simbiótico *Periclimenaeus mcmichaeli* **sp. nov.**, basado en un espécimen macho recolectado cerca de Dry Tortugas, sureste del Golfo de México, Florida. Esta es la decimocuarta especie conocida del género *Periclimenaeus* Borradaile 1915, para el Atlántico oeste, y es morfológicamente muy similar a *P. wilsoni* (Hay, 1917), de la cual se puede separar por la presencia de dos dientes pequeños subdistales situados en el margen ventral del rostro, por la ausencia de espinas pequeñas o tubérculos en el margen ventral del mero del mayor y menor quelípedos, por presentar tres dientes en el borde cortante del dactilo de la quela menor y por la posición de las espinas dorsales del telson. La nueva especie presenta una proyección aguda prominente en las pleuras del tercer y cuarto segmento abdominal y tal parece que este carácter fue previamente omitido en la literatura taxonómica de las especies de este género. La nueva especie es comparada con otros congéneres similares del Atlántico oeste y de otras regiones oceánicas. Además, se presenta una diagnosis actualizada para *P. wilsoni*, y una clave para identificar las especies válidas del género del Atlántico oeste.

**Palabras clave:** *Periclimenaeus mcmichaeli*, nueva especie, Decapoda, Caridea, Palaemonidae, Dry Tortugas, Florida, Golfo de México

## Introduction

Cooperative studies by the Florida Independent Monitoring (FIM) program of the Florida Wildlife Research Institute (FWRI) and the Southeast Area Monitoring and Assessment Program (SEAMAP), to explore the Atlantic and Gulf of Mexico coasts of Florida, has produced useful baseline data on fisheries and ecology of the region. The bycatch collections from these studies have provided interesting samples of benthic crustaceans, including a recently documented new shrimp species of palaemonid (Ramos-Tafur & Lemaitre 2016). Herein we document yet another new species of palaemonid, this time of the genus *Periclimenaeus* Borradaile, 1915, from the Dry Tortugas, Florida, on the southeastern Gulf of Mexico. This new species is most similar among the western Atlantic congeners to *P. wilsoni* (Hay, 1917). The single specimen of this new species was obtained in a trawl alongside numerous sponges, and differs from *P. wilsoni* primarily by the presence in the new species of small distoventral teeth on the rostrum, lack of armature on the ventral margin of the meri of both major and minor chelipeds, the number and shape of teeth on the cutting edge of dactylus of the minor chela, and position of the dorsal spines of telson. This new palaemonid was also found to have what seemed to be a unique and prominent character, the presence of a strong acute anteroventral projection on each pleura of the third and fourth abdominal somites. The observation in the unique specimen of this new species prompted a comparison with the types and other museum materials of the similar western Atlantic congener, *P. wilsoni*, as well as a reexamination of the taxonomic literature of the approximately 82 known species of *Periclimenaeus* (WoRMS Editorial Board 2017). Although a reexamination of specimens of all species would be needed to ascertain the presence or absence of this feature across the species of the genus, we did not find any mention in the literature of these prominent spine-like projections (e.g., Hay 1917; Hay & Shore 1918; Armstrong 1940; Holthuis 1951; Williams 1965, 1984; Bruce 1969, 1970, 1974, 1980a, 1980b, 1988, 1995, 2001, 2002, 2005a, 2005b, 2006, 2010a, 2010b, 2011, 2012a, 2012b; Abele 1971; Chace 1972; Abele & Kim 1986; Chace & Bruce 1993; Ďuriš 1990; Cardoso & Young 2007; Santos *et al.* 2008; Ďuriš *et al.* 2011a). Surprisingly, we found that the males of *P. wilsoni* exhibit the spine-like projections on the same third and fourth abdominal pleurae, although in females the spine-like projections are less developed or absent, depending on maturity and ovigerous state of the specimens. We also found that another important character, the presence of a rounded anterior median lobe on the tergite of the first abdominal somite, present in both the new species and *P. wilsoni*, has not been properly documented (e.g., Hay 1917; Hay & Shore 1918; Armstrong 1940; Holthuis 1951; Chace 1972; Cházaro-Olivera *et al.* 2013).

We provide herein a full description of this new species of palaemonid shrimp discovered in the Dry Tortugas, the 14<sup>th</sup> of the genus known from the western Atlantic. Also, a diagnosis of *P. wilsoni* is included in this study, along with an updated key to aid in the identification of all western Atlantic species of *Periclimenaeus*.

## Materials and methods

The holotype was fixed in 10% formalin, and subsequently transferred to 90% ethanol. Stained with a solution of 95% ethanol, Rose Bengal disodium salt and glycerin. To improve the visualization of some small structures under a compound microscope, the mouthparts were stained with chlorazol black. Drawings were prepared with the aid of a drawing tube attached to a Stereoscope Olympus SZX16 and a Leitz GM-Lux compound microscope. Stacked pictures of small structures were taken with a Canon T6i camera attached to a photo port of Zeiss Axio vert, A1 inverted compound microscope with plastic Differential Interference Contrast (DIC), and processed with the software Zerene Stacker (<http://zerenesystems.com/cms/home>). The pictures and pencil drawings were inked digitally with aid of a Wacom Intuos tablet and pen in Adobe Illustrator CS5, following Coleman (2003, 2006, 2009). The holotype has been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). Additional material examined remains deposited in the FWRI Invertebrate Collection, Saint Petersburg, Florida (FSBCI).

General morphological terminology is according to Holthuis (1955, 1993). Mouthparts setae terminology follows Watling (1989), Garm (2004a, b), and Garm & Watling (2013). In the illustrations of the mouthparts, the complex setae have been simplified to show only general setation presence, pattern, and density, with most ramifications and microscopic details omitted. The classification of the family Palaemonidae is as proposed by De Grave *et al.* (2015). Measurements of specimens (in mm) were made with the aid of a caliper to the nearest 0.1 mm

or with a calibrated ocular micrometer. Carapace length (CL) was measured from tip of rostrum to posterior margin of carapace; postorbital carapace length (POCL) from postorbital margin to posterior margin of carapace, and total body length (TL), from tip of rostrum to distal end of telson. The geographic locations were plotted using Esri®ArcMap™ 10.3 software. The abbreviation SMP refers to SEAMAP, as used in the labels for the samples obtained from that program.

## Systematics

### Family Palaemonidae Rafinesque, 1815

### Genus *Periclimenaeus* Borradaile, 1915

#### *Periclimenaeus mcmichaeli* sp. nov.

(Figs. 1–5)

**Holotype.** Male, CL 8.9 mm, POCL 5.8 mm, TL 19.5 mm, R/V *Tommy Munro*, station SMP 171402077, 24°45'44"N, 83°37'38"W, about 75 km W of Dry Tortugas National Park, Florida, Gulf of Mexico, 15 June 2014, 66–67 m, bottom trawl, USMN (1441819).

**Description of male holotype.** Carapace smooth (Fig. 1), glabrous; supraorbital, epigastric and hepatic areas unarmed, lacking teeth or spines; antennal spine well developed, terminating acutely, reaching middle part of basicerite. Branchiostegal area broadly rounded, slightly projected anteriorly; cardiac and hepatic regions unarmed, margins smooth, rounded.

Rostrum long, straight, slightly inclined (Figs. 2A, C), compressed laterally, overreaching distal end of third antennular segment by more than 1.2 length of third antennular segment; dorsal margin armed with 11 acute, evenly distributed teeth from tip to orbital margin, and having short setae between teeth; ventral margin slightly convex, naked, armed with 2 small subdistal teeth positioned at about level of second dorsal tooth of rostrum (Fig. 2C).

Eyes well developed (Figs. 2B, C), distal margin of cornea reaching to about 0.6 length of first antennular segment, or to level of fourth and fifth dorsal teeth of rostrum. Peduncle inflated medially, wider than cornea.

First antennular segment about 2.1 times as long as wide, lateral margins sinuous, distolateral margin projected as acute tooth with tip reaching distal third of second antennular segment, ventromesial margin with tiny acute tooth; second segment unarmed, about 0.8 as long as third antennular segment. All segments with short setae (Fig. 2C).

Right stylocerite ending in acute tooth, with tip not reaching distal margin of cornea; left stylocerite similar (tip broken during capture). Scaphocerite well developed, about 2.2 times as long as wide, slightly overreaching distal margin of third antennular segment; lateral margin slightly concave, ending in acute distolateral tooth not exceeding distal margin of squamous portion. Basicerite subquadrangular, unarmed. Carpcerite distal end overreaching slightly distal margin of second antennular segment.

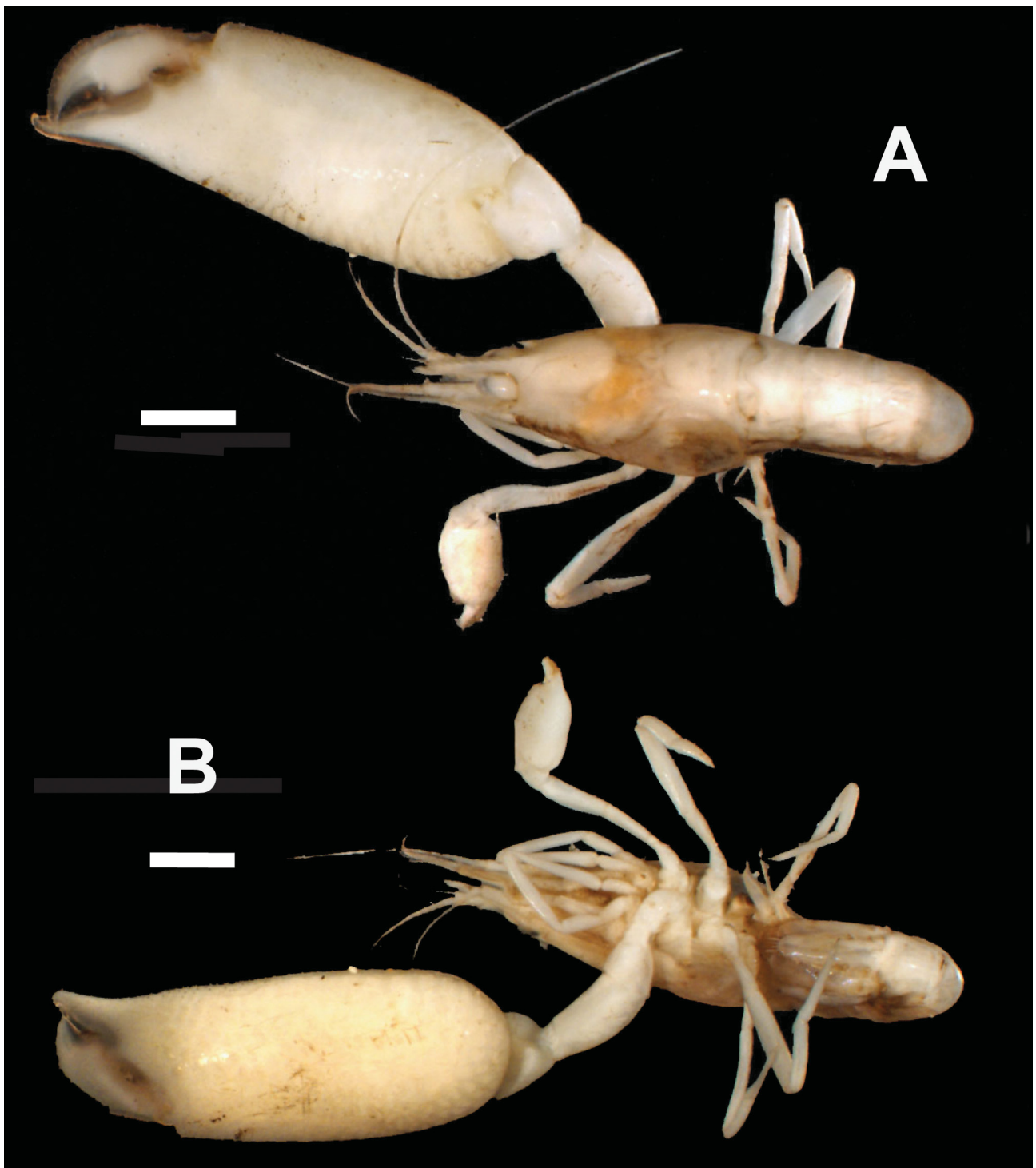
Mandible (Fig. 3A) without palp. Incisor process elongate, tapering distally and ending in 2 small acute teeth; molar process robust, broadly truncate distally, with 3 rounded teeth plus 1 small acute tooth on inferior angle. Left and right mandibles similar.

Maxillule (Fig. 3B) with palp well developed, distally bilobed, upper lobe rounded, short; inferior lobe subrectangular, slightly curving inwardly, with 2 distal, recurved spinules, lower spinule with globose base (Fig. 3C); endite bilobed, with lower lacinia foot-shaped, expanded distally and with 12 long, slender marginal pappose setae; upper lacinia broad, upper margin convex, mesial margin furnished with numerous setae, some pappose, others stout, cuspidate and having rugose protuberances or irregular scales distomedially (Fig. 3D).

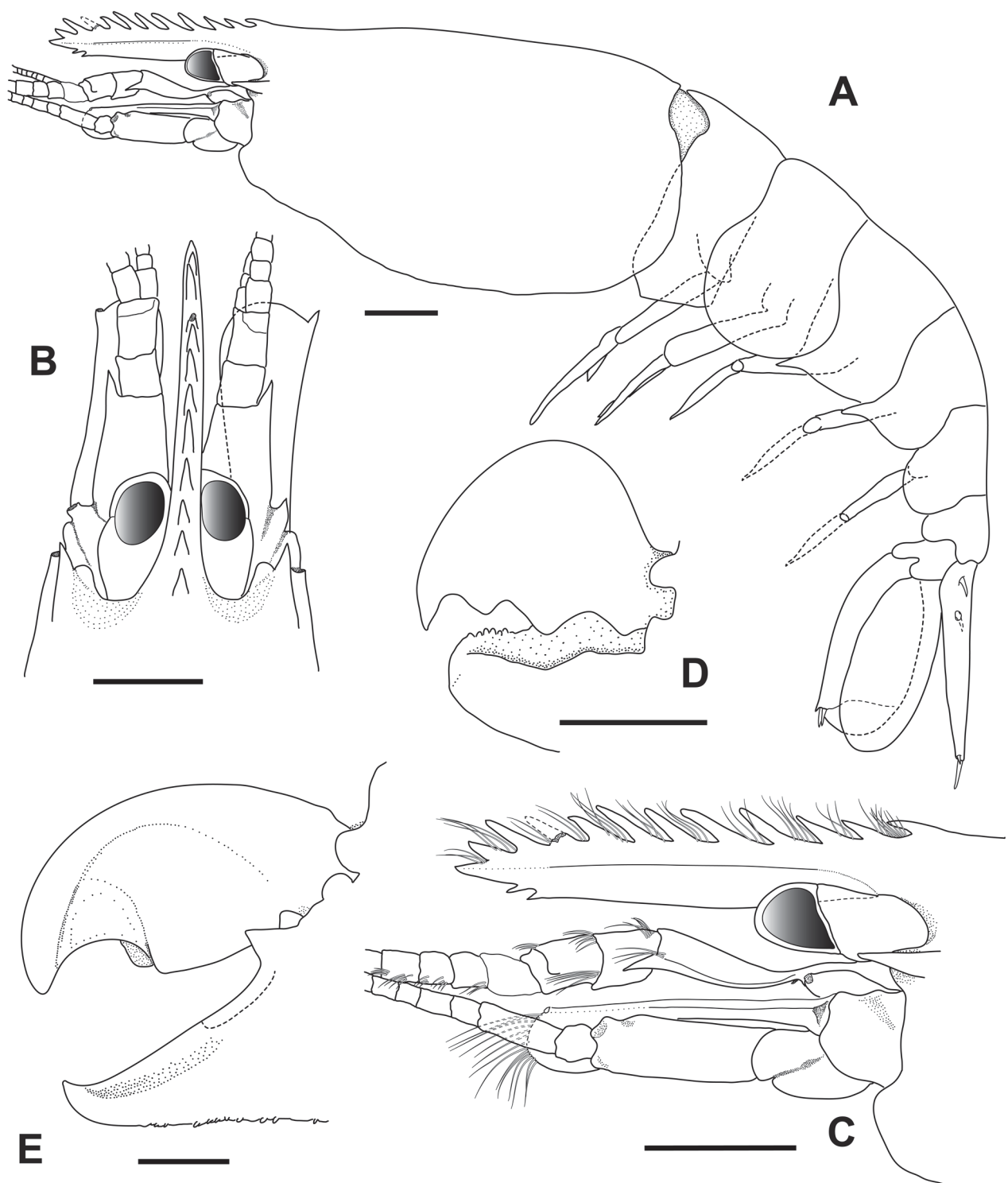
Maxilla (Fig. 3E) with scaphognathite ovoid, well developed, anterior lobe more slender than posterior lobe, margins covered by dense plumose setae. Palp simple, without setae, reaching to mid-level of scaphognathite anterior lobe. Distal endite entire, with 19 distomarginal plumose setae.

First maxilliped (Fig. 3F) with elongated palp not reaching distal margin of caridean lobe and with 2 simple subdistal and 1 simple distal seta (Fig. 3G). Exopodal flagellum long, exceeding caridean lobe by more than half its

length; with several marginal short simple setae on distal half, and 5 long apical plumose setae. Caridean lobe well developed, with marginal plumose setae. Epipod bilobed, without setae, upper lobe rounded, lower lobe subrectangular. Endite ovoid, without clear division between distal and proximal endites, and short plumose setae present on median and distal margins.

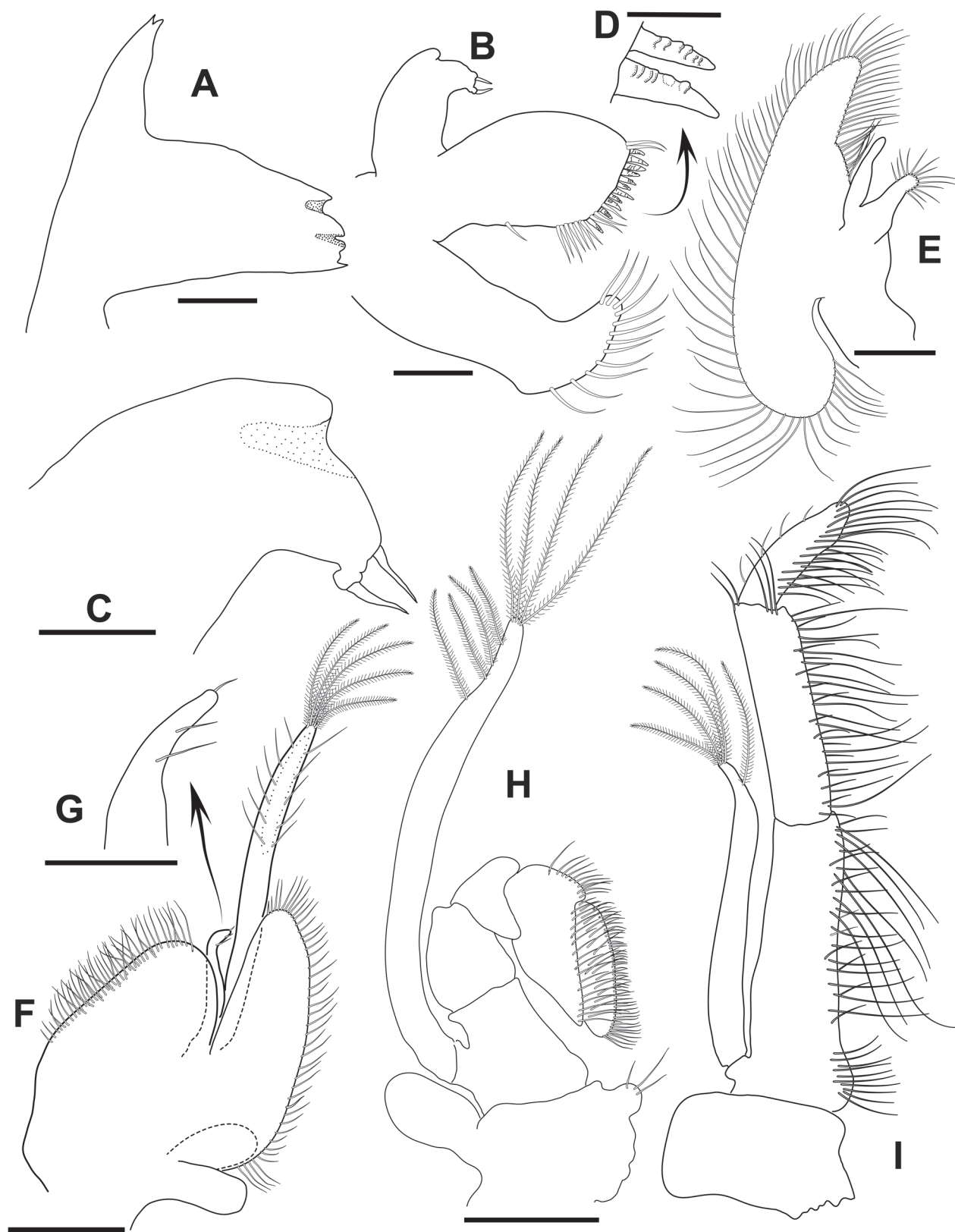


**FIGURE 1.** *Periclimenaeus mcmichaeli* **sp. nov.** holotype male, eastern Gulf of Mexico, west of Dry Tortugas, Florida (USNM 1441819): A, habitus dorsal view; B, same, ventral view. Scales equal 2 mm.

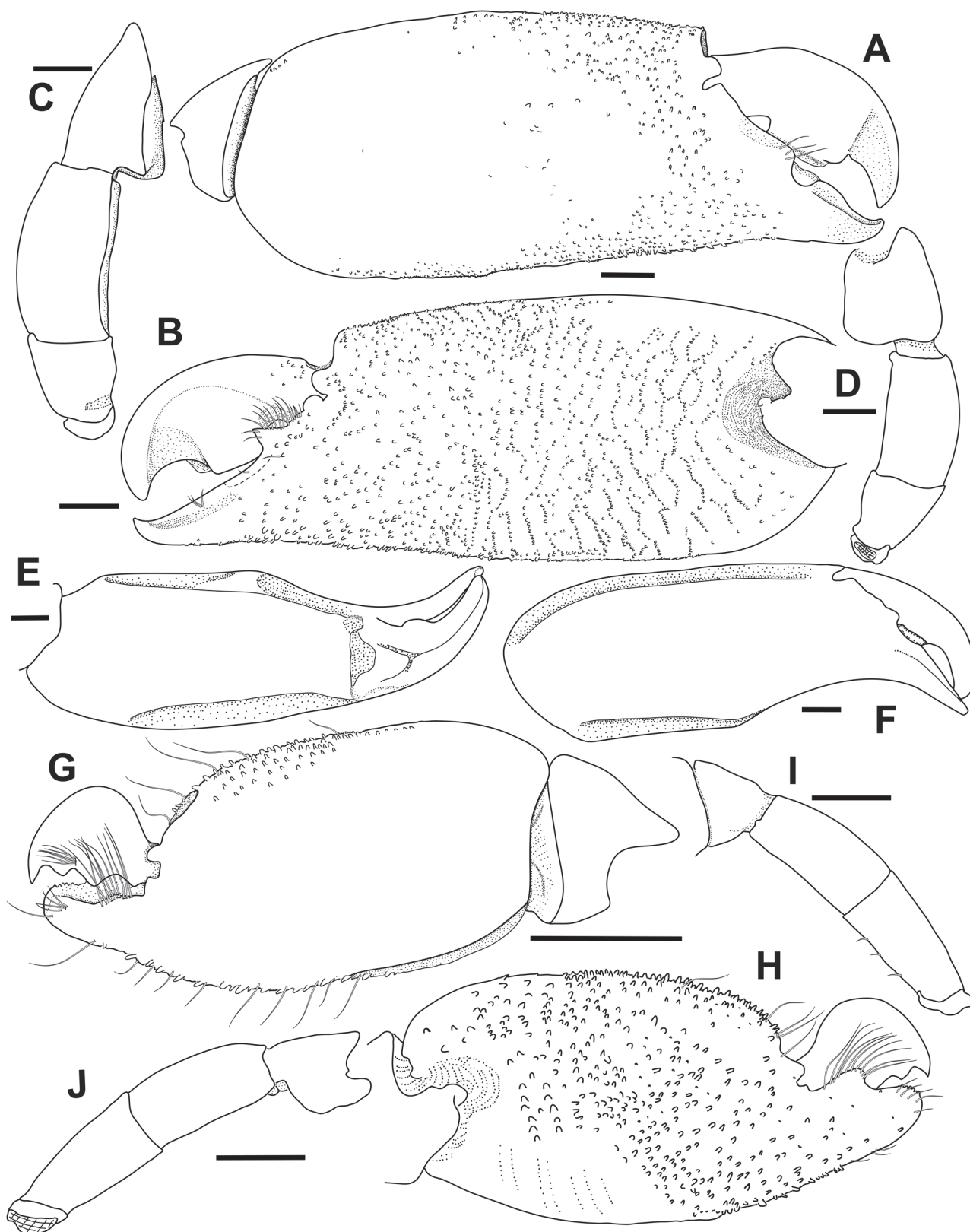


**FIGURE 2.** *Periclimenaeus mcmichaeli* **sp. nov.** holotype male, eastern Gulf of Mexico, west of Dry Tortugas, Florida (USNM 1441819): A, body, lateral view (all pereopods omitted); B, anterior portion of carapace with cephalic appendages, dorsal view; C, same, lateral view; D, fingers of minor cheliped, external view (setae omitted); E, fingers of major cheliped, mesial view (setae omitted). Scales equal 1 mm (A–C, E), 0.5 mm (D).

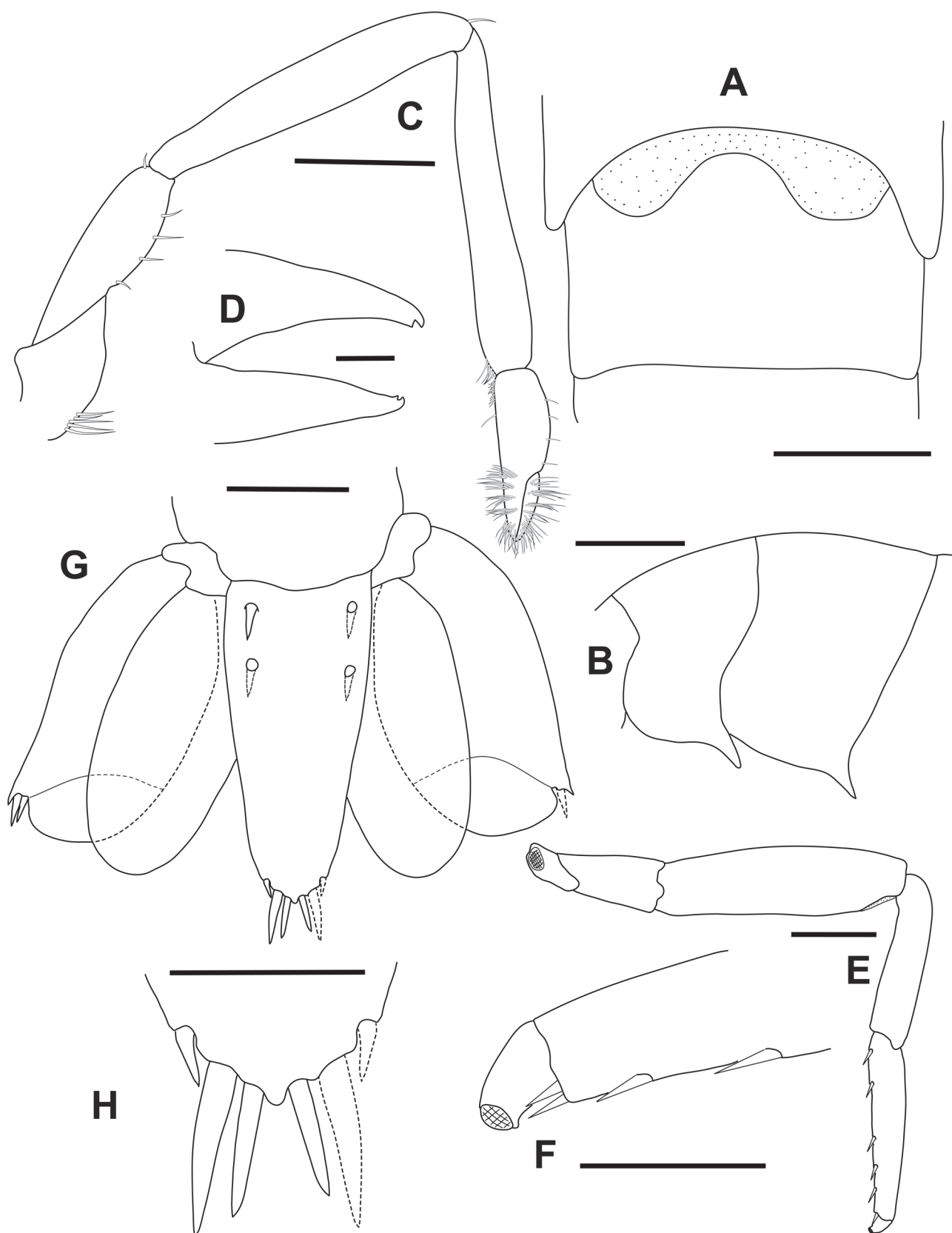




**FIGURE 3.** *Periclimenaeus mcmichaeli* **sp. nov.** holotype male, eastern Gulf of Mexico, west of Dry Tortugas, Florida (USNM 1441819). Right mouthparts, lateral view, A, mandible; B, maxillule; C, same, palp detail; D, same, upper lacinia setae detail; E, maxilla; F, first maxilliped; G, same, palp detail; H, second maxilliped; I, third maxilliped. Scales equal 0.2 mm (A, B), 0.1 mm (C, D, G), 0.5mm (E, F, H), 1 mm (I).



**FIGURE 4.** *Periclimenaeus mcmichaeli* sp. nov. holotype male, eastern Gulf of Mexico, west of Dry Tortugas, Florida (USNM 1441819): A, major chela, lateral view; B, same, mesial view; C, carpus, merus and ischium of major cheliped, lateral view; D, same, mesial view; E, major chela, dorsal view; F, same, ventral view; G, minor chela, lateral view; H, same, mesial view; I, carpus, merus and ischium of minor cheliped, lateral view; J, same mesial view. Scales equal 1 mm.



**FIGURE 5.** *Periclimenaeus mcmichaeli* sp. nov. holotype male, eastern Gulf of Mexico, west of Dry Tortugas, Florida (USNM 1441819): A, tergite of first abdominal somite, dorsal view; B, third and fourth abdominal somites, lateral view; C, right first pereopod, lateral view; D, fingers of same, lateral view; E, right third pereopod, external view; F, distal part of propodus, and dactylus (tip broken) of same, mesial view; G, telson and uropods, dorsal view; H, distal part of telson, dorsal view. Scales equal 1 mm (A-C, E, G), 0.1 mm (D), 0.5 mm (F, H).



Second maxilliped (Fig. 3H) with dactylar segment elongated, ovoid, furnished with abundant cuspidate setae; propodal segment slightly produced on inferior and superior margins, with several pappose setae on superior margin and on articulation with dactylar segment; carpus cup shape, without setae; merus and ischio-basis both without setae; exopod elongated, with 4 long subdistal plumose setae and 4 long distal plumose setae. Epipod rounded. Medial margin of coxa projected distally as rounded protuberance, furnished with 3 submarginal simple setae.

Third maxilliped (Fig. 3I) with tip overreaching distal end of carpocerite by 0.5 length of ultimate segment. Coxa distoventrally rounded, slightly projected, unarmed, without setae or spines; lateral plate subquadrangular, with rounded corners; without arthrobranch. Basis with ventral margin slightly projected, with 12 plumose setae. Ischio-merus fused to basis, about 4.0 times as long as wide, with ventral and dorsal margins sinuous, ventral margin covered with abundant marginal plumose setae. Penultimate segment about 4.3 times as long as wide, about 0.8 as long as antepenultimate segment, ventral margins covered with abundant plumose setae, and small bunch of short plumose setae on distoventral and distodorsal margins; ultimate segment about 0.6 times length of penultimate segment, slightly tapering distally, distal end rounded, covered with abundant plumose setae; dorsal margin with scarce tiny setae. Exopod elongated, tip reaching near proximal third of antepenultimate segment, with 4 long distal plumose setae and single plumose seta on ventral margin close to the tip.

First pair of pereopods (Fig. 5C) similar left from right in shape and length, overreaching tip of rostrum by entire length of carpus. Basis with 5 setae on proximoventral margin. Ischium about 0.3 length of merus, ventral margin convex, slightly swollen, with scarce small simple setae, distal end of dorsal margin with single short plumose seta. Carpus and merus subequal in length; distal end of dorsal margin of merus with single seta; ventrodistal margin of propodus with several plumose setae. Chela about half length of carpus; fingers about 0.4 as long as chela, tips of fingers bifid (Fig. 5D), cutting edges each covered with short plumose setae and slender straight spinules; external surface of palm and fingers with abundant tufts of plumose setae.

Second pair of pereopods dissimilar in size and shape (Figs. 1A, B). Right second pereopod or major cheliped massive, distinctly longer than body when tail is bent. Ischium about 0.45 as long as merus (Figs. 4C, D); with strong excavation proximally. Merus about 1.9 times as long as broad, dorsal margin concave, inferior margins sinuous, smooth, with 2 minute tubercles (visible only under high magnification), distal margins not projected. Carpus subtriangular in external view, subquadrangular in mesial view; inferior and superior margins projected, each ending in rounded knob. Chela about 2.5 times as long as wide, fingers about 0.3 as long as chela; palm ovoid in cross section; external surface of palm (Fig. 4A) with numerous dense, small tubercles and pits on distal half; fixed finger with tip ending in rounded tooth, cutting edge deeply excavated, forming fossa to receive dactylus plunger and partially covered by rounded marginal elevation with scarce setae; with conspicuous rounded projection on upper part of dactylar articulation followed by narrow U-shaped notch. Dactylus compressed, dorsal margin rounded, ending in triangular acute tip; cutting edge armed with subrectangular plunger having ventral margin slightly concave. Mesial surface of palm (Fig. 4B) almost totally covered with dense, small tubercles arranged in proximal half forming as irregular honeycomb pattern; proximodorsal margin with semiovoid smooth unarmed area extending to margin of carpus. Pollex with well-defined fossa, cutting edge between fossa and tip of finger laminar (Fig. 2E). Dactylar articulation flanked with acute triangular tooth very close to fossa and with several small setae, followed dorsally by 2 conspicuous rounded protuberances separated by narrow notch. In ventral and dorsal view (Figs. 4E, F) distal half of chela abruptly changing to strong concavity and forming internal curvature of fingers.

Left second pereopod (Figs. 4G–J) or minor cheliped overreaching tip of rostrum by almost entire length of chela. Ischium and merus subequal in size, dorsal margins convex; ventral margin of ischium with scarce small setae, ventral margin of merus smooth, without setae or protuberances; distal margins not projected. Carpus cup shape in external view; in mesial view with swollen irregular protuberances to accommodate articulation of chela in oblique position. Chela ovoid in lateral view; palm subrectangular in cross section, nearly 2.0 times as long as wide; fingers about 0.25 as long as chela. Palm external face with pits and small tubercles on dorsodistal half and inferior margin between fixed finger and middle section, with scarce few setae; ventroproximal half of palm with longitudinal elongated groove. Fixed finger with tip broadly truncated, cutting edge with groove or canal to accommodate armature of dactylus when fingers closed, with several long marginal setae; dactylar articulation flanked by small subtriangular and rounded knob separated by wide subquadrangular notch. Dactylus compressed, laminar, strongly convex dorsally, ending in acute tip, cutting edge with 3 well developed, subequal, evenly

separated subtriangular teeth (Fig. 2D), with cluster of small setae between second and third teeth. Mesial surface of palm covered almost entirely with dense small tubercles and pits; fixed finger with proximal part elevated as subtriangular knob, dorsally with several long setae, and distally with series of small crenulations (Fig. 2D); dactylar articulation flanked by elevated rounded knob with scarce long setae, and deep subrectangular notch with small rounded knob on bottom.

Third pereopod (Fig. 5E) overreaching tip of rostrum by entire length of propodus. Basis unarmed. Ischium without teeth or spines, about twice as long as wide. Merus slightly swollen dorsally, about 4.0 times as long as broad, unarmed, with shallow depression on ventrodistal margin. Carpus unarmed, about 4.1 times as long as broad, dorsal margin slightly projected distally. Propodus about 5.0 times as long as broad, armed with row of 5 or 6 spines on ventral margin and pair of spines flanking dactylar articulation. Dactylus tip (Fig. 5F) broken off.

Fourth and fifth legs similar to third leg except slenderer, fourth longer than fifth. Propodus of fifth leg with tiny spines on ventral margin, and small tuft of distal setae. Dactylar tips of fourth to fifth pereopods or walking legs with tips broken off.

Abdomen (Fig. 2A) smooth, glabrous, slightly compressed laterally. First pleopod with endopod less than half size of exopod. Second pleopod with short appendix masculina, tip with four elongate plumose setae, appendix interna twice as long as appendix masculina. Sternites with transverse low keel; without spines, protuberances or processes. First abdominal somite with well-developed anterior median lobe on tergite (Figs. 2A, 5A); ventral margin of pleura forming obtuse angle submedially. Second somite with pleura broadly rounded. Third and fourth segments each with ventral margin of pleura projecting anteroventrally as prominent acute spine (Fig. 5B), posteroventral margin of pleura rounded. Fifth somite about 1.5 times as long as sixth somite; ventral margin of pleura broadly rounded. Sixth somite with ventral and posterolateral margins of pleura rounded.

Telson (Fig. 5G) 2.1 times as long as wide, subtriangular, tapering slightly distally, lateral margins nearly straight; dorsal surface with 2 pairs of spines on anterior third. Distal margin (Fig. 5H) subtriangular, ending in small rounded median tip; armed with 3 pairs of spines, lateral pair the shortest, each spine situated on outermost corner and not reaching level of median tip; intermediate pair of spines strong, longest, more than 3 times length of external pair, and about 1.25 as long as submedian pair. Lateral and submedian spines on right side lost during examination. Uropod with exopod slightly shorter than endopod; left exopod with posterolateral margin ending in acute spine flanked by a pair of movable spines; right uropodal exopod with spines missing; diaeresis slightly curved.

**Habitat.** Probably lives associated with species of Porifera. The holotype was collected with a fishing trawl together with numerous unidentified sponge specimens or pieces. The many sponge fragments attached to the body of the holotype suggest that the single specimen of *Periclimenaeus mcmichaeli* **sp. nov.** may live in association with one or more species of the sponges obtained during the trawling but became detached during collecting.

**Etymology.** This new species is named in homage to Robert “Bob” McMichael Jr., creator of Florida Independent Monitoring Program (FIM) of FWRI. For more than 35 years he played an important role as founder and director of FIM program, produced at least 40 scientific publications on fisheries, and helped create several FIM field laboratories along both coasts of Florida.

**Color (Fig. 1).** Recorded only after recently preserved at arrival at FIM laboratory. Overall milky coloration of body and pereopods, with some dorsal areas of carapace yellow ochre. Lateral surfaces of carapace and abdomen reddish brown.

**Remarks.** *Periclimenaeus mcmichaeli* **sp. nov.** is morphologically most similar to its western Atlantic congener *Periclimenaeus wilsoni* (Hay, 1917). The two species can be separated by the following eight character differences: 1) in this new species the ventral margin of the rostrum is armed with two small subdistal teeth (Figs. 2A, C), whereas in *P. wilsoni* the rostrum is unarmed ventrally (Figs. 6A, 7A, F); 2) the tip of rostrum reaches beyond the distal margin of the third antennular segment, whereas in *P. wilsoni* the rostrum does not reach the distal margin of the antennular segment; 3) the distal margin of the cornea reaches the level of the fourth dorsal rostral tooth, whereas in *P. wilsoni* the distal margin reaches the sixth to eighth rostral teeth; 4) carpus of first pair of pereopods not inflated distally and chela is 0.5 as long as carpus (Fig. 5C), whereas in *P. wilsoni* the carpus is slightly inflated distally and chela is 0.8 as long as carpus (Fig. 6B); 5) the ventral margin of meri of second pair of pereopods is smooth, unarmed except for minute tubercles on ventral surface of the major cheliped, whereas in *P. wilsoni* the ventral margin of carpi of major and minor chelipeds is armed with an irregular row of small tubercles; 6) in the holotype male of the new species, the cutting edge of the dactylus of minor cheliped is armed with three

well developed teeth, whereas in males of *P. wilsoni* the cutting edge is armed with a rectangular tooth (Figs. 6C, D); 7) telson with two pairs of dorsal spines, both situated on anterior third, whereas in *P. wilsoni* the first pair is situated near the anterior margin, and the second pair just posterior to midlength of telson; and 8) distal margin of the telson is subtriangular and terminates in a small median knob, whereas in *P. wilsoni* the distal margin is slightly concave throughout (Holthuis 1951: 262, pl. 31b).

At least in recently preserved specimens, the milky white coloration of *P. mcmichaeli* **sp. nov.** is similar to that previously described for *P. wilsoni* by Hay & Shore (1918: 395, as *Coralliocaris wilsoni*) and Williams (1986: 83).

*Periclimenaeus mcmichaeli* **sp. nov.** can be separated from other western Atlantic congeners by the armature of the ventral margin of the rostrum. In *P. mcmichaeli* **sp. nov.** the ventral margin is armed with two subdistal teeth, whereas in other congeners the ventral margin is unarmed. In one congener, *P. caraibicus* Holthuis 1951, there is a single subterminal ventral tooth (Holthuis 1951: 269, pl. 34a) that should not be confused as being subdistal in position. Furthermore, *P. caraibicus* has one supraorbital tooth or protuberance on the carapace, whereas *P. mcmichaeli* **sp. nov.** does not.

*Periclimenaeus mcmichaeli* **sp. nov.** bears some similarity also with two other species, *P. rhodope* (Nobili 1904) from Djibouti, Gulf of Aden, and *P. echinimanus* Āuriš, Horká & Al-Horani (2011a) from the Gulf of Aqaba, Red Sea and Great Barrier Reef, Australia. In these two other species the rostrum is armed with one or two small subterminal ventral teeth (vs. with two subdistal teeth in *P. mcmichaeli* **sp. nov.**); the tip of the rostrum does not reach the distal margin of third antennular segment (vs. tip overreaching distal end of third antennular segment); the distolateral tooth of the scaphocerite distinctly overreaches the distal end of the lamella (vs. distolateral tooth not overreaching lamella); the pleura of the third and fourth abdominal segments are unarmed, ventrally rounded (vs. with acute anteroventral projections); fingers of minor chela of second pereopods long, about 0.4–0.5 as long as the chela (vs. fingers of minor chela short, about 0.25 of chela length); the cutting edge of the dactylus has a small proximal tooth (vs. cutting edge armed with large rounded teeth); and the position of the two pairs of spines on the dorsal surface of the telson (see Bruce 1974: Figs. 1C, F; Āuriš *et al.* 2011a: Fig. 2D), with anterior pair near distal margin of sixth abdominal somite, and posterior pair near the midlength of telson (vs. with both pairs of spines on anterior third of dorsal surface of telson).

The presence of an anterior median lobe on the tergite of the first abdominal somite in *Periclimenaeus mcmichaeli* **sp. nov.** places this new species in the *P. robustus* species-group as defined by Bruce (2005a) and corroborated by Āuriš *et al.* (2011a).

Species of *Periclimenaeus* are known to live in the canals of a multitude of different sponges or inside compound ascidians, often sharing the host with species of *Synalpheus* Bate, 1888. Studies of the interaction between host sponges and shrimps, morphology of mouthparts, and stomach contents, have shown these shrimp to function as semi-parasites feeding on the host tissues although not causing major damage to the sponge host (Āuriš *et al.* 2011b; Ashelby *et al.* 2015). It appears that *P. mcmichaeli* **sp. nov.** is also associated with sponges. As previously mentioned, the holotype of this new species was collected along with numerous sponges, although not inside any of them. The sponge fragments found attached to the holotype, however, suggest that the specimen got detached from one of the sponges collected in the trawl, and thus possibly was living in association with a sponge.

### *Periclimenaeus wilsoni* (Hay, 1917)

(Figs. 6, 7)

*Coralliocaris wilsoni* Hay 1917: 71 (type locality: United States Fish Commission *Fish Hawk*, 20 miles off Beaufort, North Carolina, southeastern United States).—Hay & Shore 1918: 394, Fig. 13, pl. 27, Fig. 8.

*Periclimenes* (*Periclimenaeus*) *wilsoni*.—Armstrong 1940: 6, Fig. 3G.

*Periclimenaeus wilsoni*.—Holthuis 1951: 103, pl. 31, pl. 32, Figs. b, c.—Williams 1965: 46, Fig. 38; 1984: 82, Fig. 55.—Chace 1972: 29.—Abele & Kim 1986: 174, Figs. g–i.—Felder *et al.* 2009: 1055.—De Grave & Fransen 2011: 360.

**Type material.** Holotype: male CL 10.7 mm, POCL 6.4 mm, TL 19.4 mm, United States Fish Commission *Fish Hawk*, off Beaufort, North Carolina, southeastern coast of United States, [no depth data], in large sponge, 1 August 1914 (USNM 47957). Paratypes: 2 ovigerous females, CL 6.4, 7.8 mm, POCL 4.5, 5.5 mm, TL 10.1, 12.2 mm, same station data as holotype (USNM 47961).

**Non-types.** FSBCI, *eastern Gulf of Mexico*: 1 male, CL 5.8 mm, POCL 4.0 mm, TL 12.8 mm; 2 females, CL 3.5 mm, POCL 2.6 mm, TL 8.3 mm, and CL 3.0 mm, POCL 2.2 mm, TL 7.7 mm, R/V *Hernan Cortez*, 27°37'N, 83°28'W, ~ 80 km west of Egmont Key, W coast of Florida, 15 December 1970, 37 m, with small piece of host sponge (FSBCI 7589); 1 male, CL 8.9 mm, POCL 6.5 mm, TL 17.8 mm, R/V *Tommy Munro*, 26°41'25"N, 82°40'12"W, station SMP 1103096, ~ 40 km west of Cayo Costa, W coast of Florida, 6 June 2011, depth 12 m, bottom trawl (FSBCI 095201).

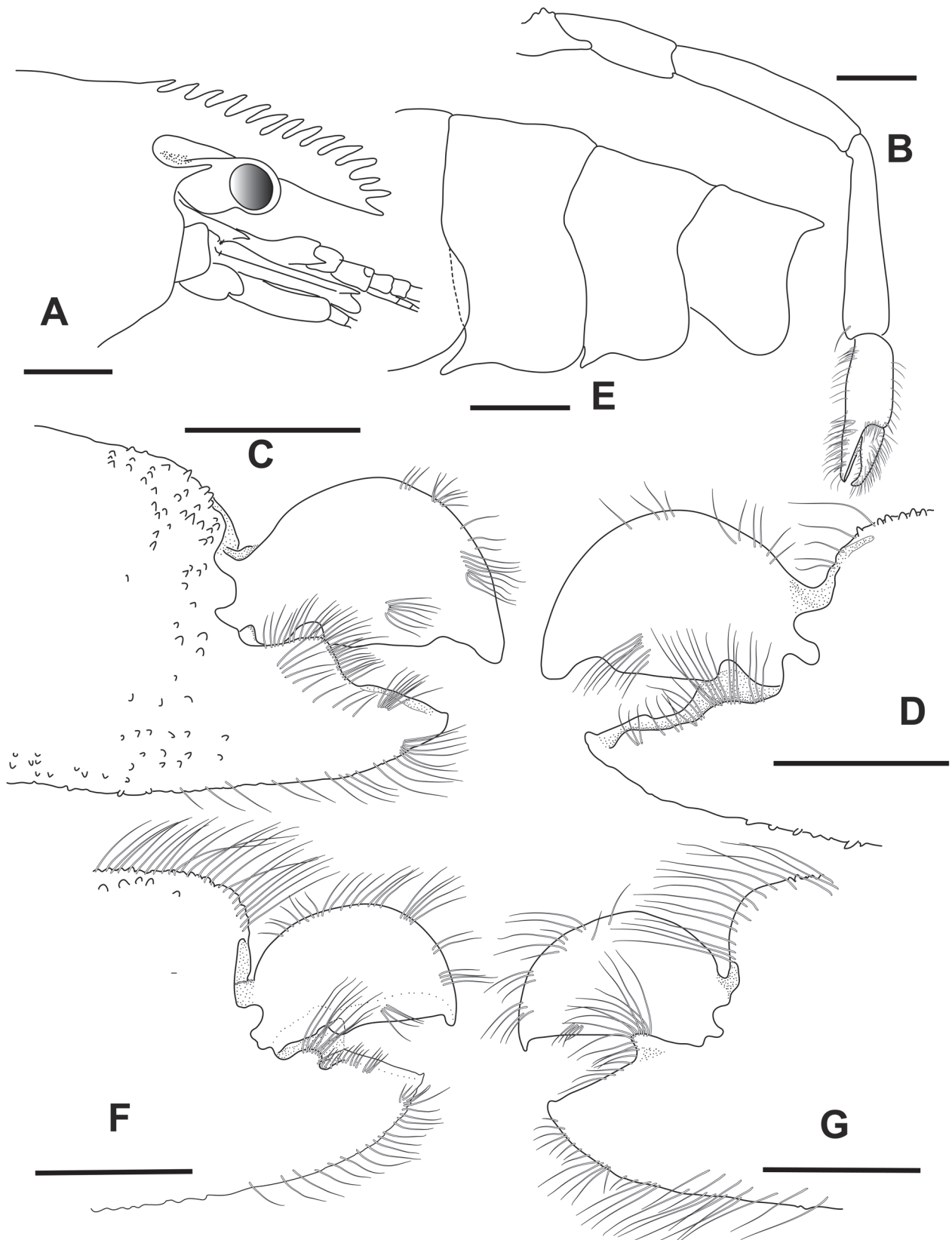
USNM, *eastern United States Atlantic coast*: 1 ovigerous female, CL 7.8 mm, POCL 5.5 mm, TL 18.7 mm, R/V *Dolphin*, sta 791072, off coast of South Carolina, 33°14'54"N, 78°24'48"W, 24 m, 27 September 1979, coll. E. Wenner (USNM 186048); 1 ovigerous female, CL 6.9 mm, POCL 4.6 mm, TL 17.4 mm, R/V *Dolphin*, sta 790905, off coast of South Carolina, 32°14'12"N, 79°45'06"W, 24 m, 2 September 1979, coll. E. Wenner (USNM 186049); 1 male, CL 7.5 mm, POCL 4.9 mm, TL 17.2 mm, 2 ovigerous females CL 6.7, 7.3 mm, POCL 4.8, 5.2 mm, TL 17.5, 18.5 mm, Sapelo Island, Georgia, sta 175, 4–5 miles SE of whistle buoy, 19.2 m, 8 January 1963 (USNM 181884).—*Eastern Gulf of Mexico*: 1 female, CL 4.3 mm, POCL 3.2 mm, TL 11.1 mm, 2 post-ovigerous females (largest with carapace separated during capture), CL 6.8, 7.4 mm, POCL 5.2, 5.5 mm, TL 17.7, 18.7 mm, R/V *Tommy Munro*, station SMP 171406172, 29°42'7"N, 84°19'36"W, ~ 50 km east of Apalachicola, NW coast of Florida, 29 October 2014, depth 18 m, bottom trawl, USNM (1441820); 2 males, CL 8.3, 7.9 mm, POCL 5.7, 5.5 mm, TL 18.0, 19.3 mm, 10 miles SE of Alligator Point, Franklin County, Florida, [no depth data], 7 July 1952, from *Ircinia* sponges, coll. M.L. Wass (USNM 95589); 1 ovigerous female, CL 6.1 mm, POCL 3.9 mm, TL 15.5 mm, off Florida, sta 45 triangle dredge, 26°03'11"N, 82°08'27"W, 17 m, 6 December 1982, coll. Continental Shelf Associates (USNM 271103); 1 ovigerous female, CL 7.5 mm, POCL 5.2 mm, TL 19.0 mm, off Florida, sta 45 quadrat (scuba), same depth and coordinates as previous, 1 June 1983, coll. Continental Shelf Associates (USNM 271104); 1 juvenile, CL 2.8 mm, POCL 1.8 mm, TL 7.1 mm, Tortugas, Florida, sta 45–30, [no depth data], 8 August 1930, coll. W.L. Schmitt (USNM 85381); 1 ovigerous female, CL 6.7 mm, POCL 4.5 mm, TL 16.4 mm, S of Loggerhead Key, Tortugas, Florida, sta 2, red buoy, 73.1 m, 4 August 1931, coll. W.L. Schmitt (USNM 85380); 4 males, CL 7.9–9.2 mm, POCL 5.5–6.7 mm, TL 19.5–23.4 mm, 1 ovigerous female CL 7.8 mm, POCL 6.0 mm, TL 18.7 mm, 1 juvenile CL 5.2 mm, POCL 3.7 mm, TL 12.8 mm, S of Tortugas, Florida, 73.1 m, 4 August 1931, coll. W.L. Schmitt (USNM 85414).

**Diagnosis.** Rostrum elongated, armed with 8–13 dorsal teeth in males (Figs. 6A, 7A), or armed with 7 or 8 dorsal teeth in females (Fig. 7F); ventral margin unarmed in both sexes; tip of rostrum in males not reaching distal margin of third antennular segment, or in females reaching only to mid-level of second antennular segment. Carapace without supraorbital spine. Antennal spine well developed. Stylocerite ending in acute tooth reaching to about mid-level of cornea. Scaphocerite reaching to about distal end of third antennular segment, lateral tooth not exceeding distal margin of lamella. Carapace anterolateral margin slightly rounded, not produced. First pair of pereopods (Fig. 6B) symmetrical, with chela about 0.7–0.8 as long as carpus. Second pair of pereopods strongly asymmetrical in shape and size. Major cheliped massive, with row of small tubercles on lower margins of ischium and merus; chela covered with numerous small tubercles arranged mesially in honeycomb pattern, fingers curved inwards distally. Minor cheliped with row of small tubercles on lower margins of ischium and merus; dactylus cutting edge in males with rectangular tooth fitting into groove of fixed finger (Figs. 6C–D), or in females with small rounded proximal tooth (Figs. 6F–G). Third pereopod with ischium, merus and carpus unarmed; propodus with few small spines on ventral margin; dactylus biunguiculate. First abdominal somite in males with anterior median lobe on tergite (lobe weakly developed or absent in juveniles and non-ovigerous females). Pleura of third and fourth abdominal somites variable: in adult males each with acute anteroventral projection (Fig. 6E); in juveniles and non-ovigerous females with or without acute projections or sometimes with obtuse projection on third pleura and rounded ventral margin of fourth pleura; in ovigerous females ventral margins of both third and fourth pleura rounded. Telson with anterior pair of dorsal spines close to distal margin of sixth abdominal somite, and posterior pair just below midlength of somite; distal margin truncate, with inner and intermediate pairs of spines similar in size.

**Color.** “Clear milky white; integument so transparent that color of internal organs is plainly visible; egg masses light bluish green” (Williams 1984: 83).

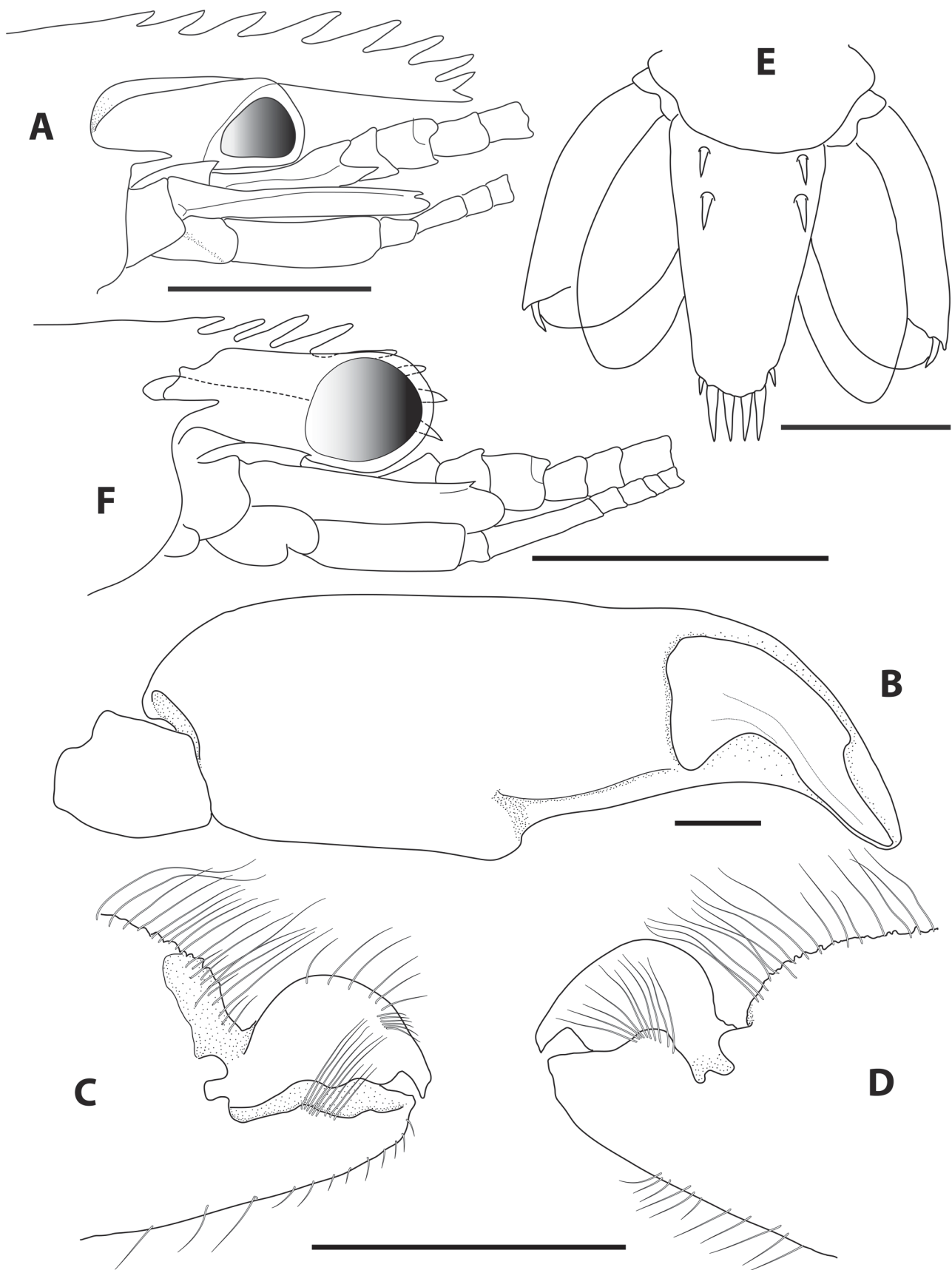
**Distribution.** Western Atlantic, southeastern United States, from North Carolina to Georgia; northern and eastern Gulf of Mexico, from Louisiana, and on Florida coast from Alligator Point east of Apalachicola Bay to Tortugas; depth: 18 to 73 m (Felder *et al.* 2009).





**FIGURE 6.** *Periclimenaeus wilsoni* (Hay, 1917), male POCL 6.5 mm (A–E), ~ 40 km west of Cayo Costa, Florida, Gulf of Mexico (FSBCI 095201); post-ovigerous female, POCL 5.5 mm (F–G), ~ 50 km east of Apalachicola, Florida, Gulf of Mexico (USNM 1441820): A, anterior part of carapace and cephalic appendages, lateral view; B, right first pereopod, lateral view; C, distal part of palm and fingers of minor chela, external view; D, same, mesial view. E, second to fifth abdominal somites, lateral view; F, distal part of palm and fingers of minor chela, external view; G, same, mesial view. Scales equal 1 mm.





**FIGURE 7.** *Periclimenaeus wilsoni* (Hay, 1917), male POCL 4.0 mm, (A–E); female POCL 2.6 mm. (F), ~ 80 km west of Egmont Key, Florida, Gulf of Mexico (FSBCI 7589): A, anterior part of carapace and cephalic appendages, lateral view; B, major chela, dorsal view; C distal part of palm and fingers of minor chela, external view; D, same, mesial view; E, telson and uropods, dorsal view; F, anterior part of carapace and cephalic appendages, lateral view. Scales equal 1 mm.

**Remarks.** The presence in *Periclimenaeus wilsoni* of an anterior median lobe on the tergite of the first abdominal somite was not mentioned in the original description by Hay (1917), or in other subsequent reports of this species by Hay & Shore (1918), Holthuis (1951), Williams (1965, 1984) and Abele & Kim (1986). Examination of the specimens reported herein obtained in recent collections, and additional specimens deposited in USNM, has shown that a median lobe on the tergite of the first abdominal somite is present also in this species, at least in adults. Thus, *P. wilsoni* can be included as well along with *P. mcmichaeli* in the *P. robustus* species-group. Furthermore, those same studies also did not document for *P. wilsoni* the presence of acute anteroventral projections on the pleura of the third and fourth abdominal somites.

The aberrant specimen depicted in Figs. 7A–E differs notably from the typical *P. wilsoni*, but probably represents this species given that the two females collected in the same lot, match the description of *P. wilsoni*. More material from the same locality would help to discern if this is an aberrant specimen or if it may represent another, perhaps undescribed taxon.

### Key to the western Atlantic species of *Periclimenaeus*

1. Carapace with small postorbital spine or tubercle; rostrum armed with 1 subterminal ventral tooth; scaphocerite with distolateral tooth overreaching distal end of lamella ..... *P. caraibicus* Holthuis, 1951 (Lesser Antilles, Barbados, Dominica, Belize to Brazil)
- Carapace without postorbital spine or tubercle; rostrum with or without subterminal ventral teeth; scaphocerite with distolateral tooth not overreaching distal end of lamella (absent in *P. schmitti* Holthuis, 1951) ..... 2
2. Male with rounded anterior median lobe on tergite of first abdominal somite, that lobe absent or weakly developed in mature females; third and fourth abdominal pleurae each with distinct anteroventral projection; minor chela fixed finger with series of long setae on either side of dactylus ..... 3
- Male and female abdomen without anterior median lobe on tergite of first abdominal somite; third and fourth abdominal pleurae rounded ventrally; minor chela fixed finger without series of long setae on dactylus ..... 4
3. Rostrum armed with 2 small subdistal teeth on ventral margin; telson with both pairs of dorsal spines on anterior third ..... *P. mcmichaeli* **sp. nov.** (off of Dry Tortugas, Florida)
- Rostrum unarmed ventrally; telson with only first pair of dorsal spines on anterior third ..... *P. wilsoni* (Hay, 1917) (North Carolina to Georgia; Gulf of Mexico: Louisiana and Florida)
4. Chelae of first pereopods with distal cutting edge of fingers with row of minute denticles (pectinate) ..... *P. pectinidactylus* Āuriš Horká & Sandford 2009 (Belize)
- First pereopods chelae with fingers furnished with setae but never with denticles ..... 5
5. First pair of pereopods distinctly long and slender, with carpus nearly twice as long as chela ..... *P. perlatus* (Boone, 1930) (Tortugas, Haiti, Veracruz, Mexico to Panama and Brazil)
- First pair of pereopods not long and slender, carpus as long as or slightly longer than chela ..... 6
6. Rostrum short, tip not reaching or slightly overreaching distal margin of corneas ..... 7
- Rostrum long, tip distinctly overreaching distal margin of the corneas ..... 10
7. Rostrum short, tip barely overreaching distal end of antennal spine, dorsal teeth contiguous, serrate in appearance ..... *P. pearsei* (Schmitt, 1932) (Dry Tortugas, Florida, Veracruz, Mexico, and Brazil)
- Rostrum overreaching distal margin of antennal spine, dorsal teeth evenly spaced ..... 8
8. Scaphocerite without distolateral tooth ..... *P. schmitti* Holthuis, 1951 (Dry Tortugas, Florida)
- Scaphocerite with distolateral tooth ..... 9
9. Dactylus of third pereopod simple; rostrum with 2 dorsal teeth; first antennular segment anterolateral angle unarmed distally ..... *P. maxillulidens* Schmitt, 1936 (Cape San Blas, Florida, Bonaire)
- Dactylus of third pereopod biunguiculate; rostrum with 3 dorsal teeth; first antennular segment with anterolateral angle armed with small spine ..... *P. ascidiarum* Holthuis, 1951 (Dry Tortugas, Florida to Cape La Vela, Colombia and Brazil)
10. Rostrum with 4 dorsal teeth; anterior pair of dorsal spines of telson on anterior half ..... 11
- Rostrum with 7 or 8 dorsal teeth; telson with anterior and posterior pair of dorsal spines on anterior third ..... 12
11. Telson with anterior pair of dorsal spines near anterior margin of segment ..... *P. chacei* Abele, 1971 (west off Hernando Beach, Florida)
- Telson with first pair of dorsal spines near midlength of segment ..... *P. atlanticus* (Rathbun, 1901) (Saint Thomas, Virgin Islands to Brazil)
12. Second pereopod with dactylus of major chela overreaching tip of fixed finger ..... *P. crosnieri* Cardoso & Young, 2007 (Rocas Atoll, Brazil)
- Second pereopod with dactylus of major chela not overreaching tip of fixed finger ..... 13
13. Rostrum with 8 dorsal teeth; palm of major chela with rows of conspicuous tubercles ..... *P. brucei* Cardoso & Young, 2007 (Rocas Atoll, Brazil)
- Rostrum with 7–8 dorsal teeth; palm of major chela with few minute tubercles ..... *P. bredini* Chace, 1972 (Isla Mujeres, Quintana Roo, Mexico)

## Acknowledgements

We are deeply grateful for the collaboration of the staff of FWRI in FSBCI, Joan Herrera, Laura Wiggins, Rob Lasley, and Krista Austin, and specially Tammy Cullings for providing the photograph used for Figure 1, and sorting several lots of invertebrates recently collected. Many thanks are also extended to cooperative effort of the project FIM-SEAMAP, and the staff and crew on aboard the R/V *Tommy Munro*, all scientific and administrative staff of the FIM program, especially Ryan Jones, Scott Stahl and Chris Stafford, for providing information related to other organisms collected as well as physico-chemical data. Appreciations are extended to the following: Greg Onorato (FIM) for GIS plotting; Micah Bakenhaster (FWRI Fish and Wildlife Health), Julianne “Joolz” Knight and Brittany “Bossy” Hall (Fish Feeding Ecology Lab or Gut Lab), for their patience and help in many ways; Ed Matheson, Ted Switzer and Deb Leffler (all FIM), for kindly reviewing the first draft of this manuscript and cooperation to GERT. The valuable advice and critical comments of Zdeněk Ďuriš, University of Ostrava, Czech Republic, greatly improved the quality of this manuscript; he also generously shared valuable unpublished information on shrimps recently collected by his scientific team. Sammy De Grave, Oxford University Museum of Natural History, U.K., Robin Grunwald, FWRI Library, Saint Petersburg, Florida and Rose Gullledge, Smithsonian Institution, Washington, D.C., for their invaluable help to obtain literature. We are deeply grateful with the comments and suggestions of two anonymous reviewers that help us to improve the quality of this manuscript. Funding to GERT for the Florida SEAMAP ground fish survey was provided by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (grant # NA11NMF4350047). Additional support was provided by the proceeds from State of Florida saltwater recreational fishing licenses. The statements, findings, views, conclusions, and recommendations contained in this document are those of the authors, do not necessarily reflect the views of the US departments of Commerce, and should not be interpreted as representing the opinions or policies of the U.S. government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. government.

## References

- Abele, L.G. (1971) A new species of *Periclimenaeus* Borradaile, 1915 (Crustacea: Decapoda: Palaemonidae) from the northeastern Gulf of Mexico. *Tulane Studies in Zoology and Botany*, 17 (2), 38–40.
- Abele, L.G. & Kim, W. (1986) An illustrated guide to the marine decapod crustaceans of Florida. *State of Florida Department of Environmental Regulation Technical Series*, 8, 1–760.
- Armstrong, J.C. (1940) New species of Caridea from the Bermudas. *American Museum Novitates*, 1096, 1–10.
- Ashelby, C.W., De Grave, S. & Johnson, M.L. (2015) Preliminary observations on the mandibles of palaemonoid shrimp (Crustacea: Decapoda: Caridea: Palaemonoidea). *PeerJ*, 3, e846.  
<https://doi.org/10.7717/peerj.846>
- Bate, C.S. (1888) Report on the Crustacea Macrura collected by the Challenger during the years 1873–76. *Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873–76*, 8, i–xc, 1–942.
- Boone, L. (1930) New decapod and isopod crustaceans from Gonave Bay, Haiti. *Zoologica*, 12 (4), 41–53.
- Borradaile, L.A. (1915) Notes on Carides. *The Annals and Magazine of Natural History*, Series 8, 15, 205–213.
- Bruce, A.J. (1969) Preliminary descriptions of ten new species of the genus *Periclimenaeus* Borradaile, 1915 (Crustacea, Decapoda, Natantia, Pontoniinae). *Zoologische Mededelingen, Leiden*, 44 (12), 159–176.
- Bruce, A.J. (1970) Further preliminary descriptions of new species of the genus *Periclimenaeus* Borradaile, 1915 (Crustacea, Decapoda, Natantia, Pontoniinae). *Zoologische Mededelingen, Leiden*, 44 (21), 305–315.
- Bruce, A.J. (1974) Observations upon some specimens of the genus *Periclimenaeus* Borradaile (Decapoda Natantia, Pontoniinae) originally described by G. Nobili. *Bulletin du Muséum national d'Histoire naturelle, Zoologie, Paris*, 3e Série, 258, 1557–1583.
- Bruce, A.J. (1980a) Notes on some Indo-Pacific Pontoniinae, 33. *Periclimenaeus diplosomatis* sp. nov., an ascidian associate from Heron Island, Australia. *Crustaceana*, 39 (1), 39–51.  
<https://doi.org/10.1163/156854080X00283>
- Bruce, A.J. (1980b) SEM observations on the ambulatory dactyls of some pontonine shrimps (Decapoda Caridea). *Crustaceana*, 38 (2), 178–182.  
<https://doi.org/10.1163/156854080X00616>
- Bruce, A.J. (1988) A redescription of *Periclimenaeus fimbriatus* Borradaile, 1915, with the designation of a new genus (Crustacea: Decapoda: Palaemonidae). *Zoological Journal of the Linnean Society*, 94, 219–232.  
<https://doi.org/10.1111/j.1096-3642.1988.tb01193.x>
- Bruce, A.J. (1995) A Synopsis of the Indo-West Pacific Genera of the Pontoniinae (Crustacea: Decapoda: Palaemonidae).

*Theses Zoologicae*, 25 (imprint 1994, published 1995), 1–172.

- Bruce, A.J. (2001) A re-examination of *Periclimenaeus trispinosus* Bruce and *P. orbitospinatus* Bruce (Crustacea: Decapoda: Pontoniinae). *Zoologische Mededelingen, Leiden*, 75 (9), 147–158.
- Bruce, A.J. (2002) A redescription of *Periclimenaeus tridentatus* (Miers, 1884), based on specimens from Port Essington, Northern Territory, and a note on *P. hecate* (Nobili, 1904) (Crustacea: Decapoda: Pontoniinae), with a key for the preliminary identification of the tunicate-associated species of *Periclimenaeus* Borradaile. *Journal of Natural History*, 36, 565–584.  
<https://doi.org/10.1080/00222930010015870>
- Bruce, A.J. (2005a) A re-description of *Periclimenaeus robustus* Borradaile, the type species of the genus *Periclimenaeus* Borradaile, 1915 (Crustacea: Decapoda: Pontoniinae). *Cahiers de Biologie marine*, 46, 389–398.
- Bruce, A.J. (2005b) New species of *Periclimenaeus* Borradaile (Crustacea: Decapoda: Pontoniinae) from Ashmore Reef, North Western Australia, with remarks on *P. pachydentatus* Bruce, 1969. *Records of the Western Australian Museum*, 22, 325–342.  
[https://doi.org/10.18195/issn.0312-3162.22\(4\).2005.325-342](https://doi.org/10.18195/issn.0312-3162.22(4).2005.325-342)
- Bruce, A.J. (2006) *Periclimenaeus nielbrucei* sp. nov. (Crustacea: Decapoda: Pontoniinae), a new sponge associate from the Capricorn Islands, Queensland, with notes on related *Periclimenaeus* species. *Zootaxa*, 1224, 1–22.
- Bruce, A.J. (2010a) *Periclimenaeus devaneyi* sp. nov., from Oahu, Hawai'i (Crustacea: Decapoda: Pontoniinae). *Zootaxa*, 2372, 379–388.
- Bruce, A.J. (2010b) A revision of the systematic position of *Periclimenaeus spinimanus* Bruce, 1969 (Crustacea: Decapoda: Pontoniinae) and the designation of *Anisomenaeus* gen. nov. *Zootaxa*, 2372, 338–340.
- Bruce, A.J. (2011) *Periclimenaeus pulitzerfinali* sp. nov. (Crustacea: Decapoda: Palaemonidae), a new pontonine shrimp from East Africa. *The Beagle, Records of the Museums and Art Galleries of the Northern Territory*, 27, 113–121.
- Bruce, A.J. (2012a) *Periclimenaeus parkeri* sp. nov. (Crustacea: Decapoda: Pontoniinae) from the Kimberley, Western Australia. *Cahiers de Biologie Marine*, 53, 289–298.
- Bruce, A.J. (2012b) Notes on some Indo-Pacific Pontoniinae, 51. *Periclimenaeus quadridentatus* (Rathbun, 1906) and *P. crassipes* (Calman, 1939) (Decapoda, Pontoniinae), with the designation of *P. calmani* and *P. serenei* spp. nov. *Crustaceana*, 85 (4–5), 513–531.  
<https://doi.org/10.1163/156854012X624682>
- Cardoso, I.A. & Young, P.S. (2007) Caridea (Crustacea, Decapoda: Disciadidae, Palaemonidae, Processidae, Rhynchocinetidae) from Rocas Atoll including two new species of *Periclimenaeus* Borradaile, 1951. *Arquivos do Museu Nacional, Rio de Janeiro*, 65 (3), 277–337.
- Chace, F.A. Jr. (1972) The shrimps of the Smithsonian-Bredin Caribbean expeditions with a summary of West Indian shallow-water species (Crustacea: Decapoda: Natantia). *Smithsonian Contributions to Zoology*, 98, 1–179.  
<https://doi.org/10.5479/si.00810282.98>
- Chace, F.A. Jr. & Bruce, A.J. (1993) The Caridean shrimps (Crustacea: Decapoda) of the *Albatross* Philippine Expedition, 1907–1910, part 6: Superfamily Palaemonoidea. *Smithsonian Contributions to Zoology*, 543, 1–152.  
<https://doi.org/10.5479/si.00810282.543>
- Cházaro-Olivera, S., Winfield, I., Barcena-Cisneros, M. & Ortiz, M. (2013) Species of the genus *Periclimenaeus* (Decapoda, Caridea, Palaemonidae) associated with sponges from the Veracruz coral reef system national park, SW Gulf of Mexico. *Crustaceana*, 86 (6), 641–650.  
<https://doi.org/10.1163/15685403-00003168>
- Coleman, C.O. (2003) "Digital inking": How to make perfect line drawings on computers. *Organism, Diversity and Evolution*, 14 (Electronic Supplement), 1–14. Available from: <http://senckenberg.de/odes/03-14.htm> (accessed 11 July 2017)
- Coleman, C.O. (2006) Substituting time-consuming pencil drawings in arthropod taxonomy using stacks of digital photographs. *Zootaxa*, 1360, 61–68.
- Coleman, C.O. (2009) Drawing setae the digital way. *Zoosystematics and Evolution*, 85 (2), 305–310.  
<https://doi.org/10.1002/zoos.200900008>
- De Grave, S. & Fransen, C.H.J.M. (2011) Carideorum catalogus: the recent species of the dendrobranchiate, stenopodidean, procarididean and caridean shrimps (Crustacea: Decapoda). *Zoologische Mededelingen, Leiden*, 89 (5), 195–589.
- De Grave, S., Fransen, C.H.J.M. & Page, T.J. (2015) Let's be pals again: major systematic changes in Palaemonidae (Crustacea: Decapoda). *PeerJ*, 3, e1167.  
<https://doi.org/10.7717/peerj.1167>
- Đuriš, Z. (1990) Two new species of the commensal shrimp genus *Periclimenaeus* Borradaile, 1915, (Decapoda, Palaemonidae) from the Maldives Islands. *Journal of Natural History*, 24, 615–625.  
<https://doi.org/10.1080/00222939000770411>
- Đuriš, Z., Horká, I. & Sandford, F. (2009) *Periclimenaeus pectinidactylus* n. sp. (Crustacea: Decapoda: Pontoniinae) from the Belizean Barrier Reef, Caribbean Sea. *Zootaxa*, 2130, 31–40.
- Đuriš, Z., Horká, I. & Al-Horani, F. (2011a) *Periclimenaeus echinimanus* sp. nov. (Crustacea: Decapoda: Pontoniinae), a new species from the Gulf of Aqaba, Red Sea. *Zootaxa*, 2983, 57–68.
- Đuriš, Z., Horká, I., Juračka, P.J., Petrusek, A. & Sandford, F. (2011b) These Squatters Are Not Innocent: The Evidence of Parasitism in Sponge-Inhabiting Shrimps. *PLoS ONE*, 6 (7), e21987.



<https://doi.org/10.1371/journal.pone.0021987>

- Felder, D.L., Álvarez, F., Goy, J.W. & Lemaitre, R. (2009) Decapoda (Crustacea) of the Gulf of Mexico, with comments on the Amphionidacea. In: Felder, D.L. & Camp, D.K. (Eds.), *Gulf of Mexico Origin, Waters, and Biota. Vol. 1. Biodiversity*. Texas A&M University Press, College Station, Texas, pp. 1019–1104.
- Garm, A. (2004a) Mechanical functions of setae from the mouth apparatus of seven species of decapod crustaceans. *Journal of Morphology*, 260 (1), 85–100.  
<https://doi.org/10.1002/jmor.10213>
- Garm, A. (2004b) Revising the definition of the crustacean seta and setal classification systems based on examinations of the mouthpart setae of seven species of decapods. *Zoological Journal of the Linnean Society*, 142 (2), 233–252.  
<https://doi.org/10.1111/j.1096-3642.2004.00132.x>
- Garm A. & Watling, L. (2013) The crustacean integument: setae, setules, and other ornamentation. In: Watling, L. & Thiel, M. (Eds.), *The natural history of the Crustacea. Vol. 1. Functional morphology and diversity*. Oxford University Press, Oxford, pp. 167–198.  
<https://doi.org/10.1093/acprof:osobl/9780195398038.003.0006>
- Hay, W.P. (1917) Preliminary descriptions of five new species of crustaceans from the coast of North Carolina. *Proceedings of the Biological Society of Washington*, 30, 71–74.
- Hay, W.P. & Shore, C.A. (1918) The decapod crustaceans of Beaufort, N. C., and the surrounding regions. *Bulletin of the United States Fish Commission*, 35, 369–475.
- Holthuis, L.B. (1951) A general revision of the Palaemonidae (Crustacea Decapoda Natantia) of the Americas. I. The subfamilies Euryrhynchinae and Pontoniinae. *Allan Hancock Foundation Publications, Occasional Papers*, 11, 1–332.
- Holthuis, L.B. (1955) The recent genera of the caridean and stenopodidean shrimps (class Crustacea, order Decapoda, supersection Natantia) with keys for their determination. *Zoologische Verhandelingen, Leiden*, 26, 1–157.
- Holthuis, L.B. (1993) *The recent genera of the caridean and stenopodidean shrimps (Crustacea, Decapoda) with an appendix on the order Amphionidacea*. Natuurhistorisch Museum, Leiden, 328 pp. [Fransen, C.H.J.M. & Achterberg, C. van (Eds.)]
- Nobili, G. (1904) Diagnoses préliminaires de vingt-huit espèces nouvelles de Stomatopodes et Décapodes Macroures de la Mer Rouge. *Bulletin du Muséum d'Histoire naturelle, Série 1*, 10 (5), 228–238.
- Rafinesque, C.S. (1815) *Analyse de la Nature, ou Tableau de l'Univers et des Corps Organisés*. L'Imprimerie de Jean Barravecchia, Palermo, 224 pp.  
<https://doi.org/10.5962/bhl.title.106607>
- Ramos-Tafur, G.E. & Lemaitre, R. (2016) A new species of symbiotic palaemonid shrimp of the genus *Pseudocoutierea* Holthuis, 1951 (Decapoda: Caridea: Palaemonidae) from the eastern Gulf of Mexico, with an updated key for the identification of species of the genus. *Zootaxa*, 4173 (5), 475–482.  
<https://doi.org/10.11646/zootaxa.4173.5.4>
- Rathbun, M.J. (1901) The Brachyura and Macrura of Porto Rico. [Preprint from] *U.S. Fish Commission Bulletin for 1900* [1902], 20 (2), 1–127.
- Santos, A. dos, Calado, R. & Araújo, R. (2008) First record of the genus *Periclimenaeus* Borradaile, 1815 (Decapoda: Palaemoniidae: Pontoniinae) in the northeastern Atlantic, with the description of a new species, *Periclimenaeus aurae*. *Journal of Crustacean Biology*, 28 (1), 156–166.  
<https://doi.org/10.1651/07-2852R.1>
- Schmitt, W.L. (1932) Appendix [Description of *Corallicaris pearsei* Schmitt new species]. Pp. 123–124, in: Pearse, A.S., Inhabitants of certain sponges at Dry Tortugas. (Papers of the Tortugas Laboratory, vol. 28), *Carnegie Institution of Washington Publication*, 435, 123, 124.
- Schmitt, W.L. (1936) Macruran and Anomuran Crustacea from Bonaire, Curaçao and Aruba. Zoologische Ergebnisse einer Reisenacht, Bonaire, Curagao und Aruba im Jahre 1930. No. 16. *Zoologische Jahrbücher Abteilung für Systematik, Ökologie und Geographie der Tiere*, 67, 363–378, pls. 1–4.
- Watling, L. (1989) A classification system for crustacean setae based on the homology concept. In: Felgenhauer, B.E., Watling, L. & Thistle, A.B. (Eds.), *Functional Morphology of Feeding and Grooming in Crustacea. Crustacean Issues. Vol. 6*. A.A. Balkema, Rotterdam, pp. 15–26. [Schram, F.R. (Series ed.)]
- Williams, A.B. (1965) Marine decapod crustaceans of the Carolinas. *Fishery Bulletin of the Fish and Wildlife Service*, 65 (1), 1–298.
- Williams, A.B. (1984) *Shrimps, lobsters, and crabs of the Atlantic coast of the eastern United States, Maine to Florida*. Smithsonian Institution Press, Washington, D.C., 550 pp.
- WoRMS Editorial Board (2017) *World Register of Marine Species*. VLIZ. Available from: <http://www.marinespecies.org> (accessed 2 May 2017)